

RECENT DEVELOPMENTS IN STRUCTURE-PRESERVING DATA-DRIVEN METHODS FOR FLUIDS

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ABSTRACT

Projection-based reduced order models (ROMs) share strong connections with techniques utilized in the design and analysis of high order discretizations. However, the extension of such techniques to data-driven extensions to projection-based ROMs encounters unique challenges. This minisymposium collects recent advances in data-driven ROMs (as well as related machine-learning surrogates and data-assimilation techniques) for physics-based simulations which address challenges in achieving robust performance in extrapolatory and predictive regimes. Embedding physical structure-preserving properties (e.g., balance laws, preservation of geometric or solution invariants) can significantly improve performance in such regimes. These techniques also improve performance in the presence of challenging fluid physics, including shock waves, boundary layers, and turbulence. This minisymposium focuses on techniques for enforcing such properties within data-driven methods, which can both generalize and deviate significantly from approaches used traditional high order numerical discretizations.

SPEAKERS

1. Nat Trask (University of Pennsylvania, ntrask@seas.upenn.edu): “Developing neural PDE architectures which generalize across unseen geometry through coordinate free physics/geometry”

2. Cheng Huang (University of Kansas, chenghuang@ku.edu): “Self-Adaptive Multi-Fidelity Reduced-Order Modeling Framework for Detonation Problems”
3. Khemraj Shukla (Brown University, khemraj_shukla@brown.edu): “On finding closure for compressibility turbulence at high Mach by assimilating the DNS and Experimental data using PINNs”
4. Ismail Oubarka (Mohammed VI Polytechnic University, ismail.oubarka@um6p.ma): “WE-PINNs: A Weak and Entropy-Based Physics-Informed Neural Network for Nonlinear Hyperbolic Conservation Laws”
5. Alejandro Diaz (Sandia National Laboratories, andiaz@sandia.gov): “Coupling kernel-based non-intrusive ROMs using the Schwarz alternating method”
6. Loek Van Heyningen (Sandia National Laboratories, rlvanhe@sandia.gov): “Registration methods for ROMs of shock-dominated flows”
7. Kailiang Wu (Southern University of Science and Technology, wukl@sustech.edu.cn): “Structure-Preserving Flow-Map Learning for Unknown Equations with Structural Priors”
8. Gianluigi Rozza (SISSA, gianluigi.rozza@sissa.it): “Advances in surrogate modeling for CFD: special focus on structure preservation”
9. Jan Glaubitz (Linköping University, jan.glaubitz@liu.se): “Regularity-informed data assimilation for hyperbolic conservation laws”
10. Lizuo Liu (Dartmouth University, lizuo.liu@dartmouth.edu): “Learning hyperbolic conservation laws from data”
11. Mohammad Farazmand (North Carolina State University, farazmand@ncsu.edu): “Shape-morphing solutions of PDEs with conserved quantities”
12. Rebecca Monterumisi (Dartmouth University, rebecca.monterumisi.gr@dartmouth.edu): “Neural Operator Reconstruction of Global Bottom Topography from particle trajectory data”